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LEAKAGE STUDIES

Progress Report No. 10 for January and February, 1970

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UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE GASEOUS DIFFUSION PLANT

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LEAKAGE STUDIES PROGRESS REPORT NUMBER 10 FOR JANUARY AND FEBRUARY, 1970

Introduction and Summary

This is the tenth report of the work on leakage studies being conducted at ORGDP. The objectives of this work during fiscal year 1970 are:

1. To identify points in the gaseous diffusion cascade, the gas centrifuge cascade, and during maintenance operations where leakage of particles to the environment might occur and to determine the chemical and physical forms, abundance, and distribution of the particles. (Effluent Studies)

2. To undertake a basic investigation of the fate of uranium hexafluoride when it is released to the atmosphere. (Basic Studies)

The costs during this report period were $7,567.00. The total costs of this program for fiscal year 1970 are $40,814.00.

Background sampling of the air in the vicinity of the gaseous diffusion plant was continued at the K-25 and K-1034-A locations. Analytical data are presented for the months of January and February.

Air samples were obtained during part of the month of February at the cascade purge facility located in the K-311 building. The analytical data obtained from these samples show this location to be a continuing source of uranium-bearing effluent.

Air samples were obtained during February at the scale house, K-1215.

Air samples were obtained during February at the Company safety sign (east) on the Oak Ridge Turnpike.

Chemical analysis of mixtures of UO_2F_2 with powdered aluminum, chromium, and tungsten shows that reduction of the uranium from U^{+6} to U^{+4} occurs to a larger degree with aluminum than with chromium and tungsten on comparable exposures to local weather conditions.

Gross isotopic analyses are presented for samples taken at K-704, the K-1420 calcining facility, the K-1420 oxide transfer facility, and K-1528.

Effluent Studies

Background Sampling. Background sampling of the air in the vicinity of the gaseous diffusion plant is continuing. The locations of the two sampling points (K-25 and K-1034-A) are shown in figure 1 of this report.

Samples were obtained each working day during this report period. Each of these samples has been analyzed for the amount of soluble uranium (U^{+6}) and the total amount of uranium (U^{+6}+ U^{+4}) in the sample. The results of these analyses are shown in figures 2 and 3 of this report. For convenience, the major cascade maintenance operations are indicated at the top of each of these figures on the day they were performed. One maintenance operation, that of seal changing, has not been included because this operation occurs frequently and generally is accomplished in a period of less than four hours. Tables I and II are chronological listings of all cascade maintenance operations performed during January and February, 1970. The amount of cascade maintenance performed during this period was at a somewhat higher level than that of the previous report period.

Sampling of Cascade Purge Facility. This location (K-311-1) as shown in figure 1 has been found in the past to be a source of uranium-bearing effluent. As the effluent can be identified by gross isotopic analysis, this location is used to obtain control samples and is a focal point from which distances to other sampling locations are measured. The analytical data obtained from the cascade purge facility (K-311-1) are shown in table III.

TABLE III

URANIUM CONCENTRATION IN AIR FROM K-311-1 CASCADE PURGE FACILITY

Date of Sample	Soluble Uranium Content, (U^{+6}), µg/cu ft	Total Uranium Content, (U^{+6}+U^{+4}), µg/cu ft
February 9, 1970	9.14×10^{-2}	15.63×10^{-2}
February 10, 1970	7.92×10^{-2}	11.35×10^{-2}
February 11, 1970	1.15×10^{-2}	5.64×10^{-2}
February 12, 1970	38.53×10^{-2}	58.06×10^{-2}
February 13, 1970	96.57×10^{-2}	190.99×10^{-2}
February 16, 1970	6.68×10^{-2}	9.57×10^{-2}
February 17, 1970	3.41×10^{-2}	5.90×10^{-2}
February 18, 1970	3.28×10^{-2}	5.37×10^{-2}

The high uranium concentrations obtained on February 12 and 13 at this location cannot be explained at this time.

TABLE I

CASCADE MAINTENANCE, JANUARY 1970

Date	Type of Maintenance Performed
1	
2	
3	
4	
5	
6	Change cell evacuation valve 602-1.3
7	
8	
9	
10	
11	
12	
13	
14	
15	Seal change 502-1.6
16	Seal change 902-4.8; seal change 902-4.10
17	
18	
19	Seal change 602-1.1
20	Seal change 602-1.1; seal change 902-3.3
21	Seal change 602-1.1
22	
23	Seal change 902-6.4
24	
25	
26	Change control valve 602-3.7
27	
28	
29	
30	Seal change 502-1.1; change control valve 502-2.1
31	

TABLE II

CASCADE MAINTENANCE, FEBRUARY 1970

Date	Type of Maintenance Performed
1	Seal change 902-4.8; seal change 902-4.10
2	Seal change 602-3.7
3	
4	
5	Seal change 902-4.8; seal change 902-4.10
6	Seal change 602-1.3
7	
8	
9	
10	
11	
12	Seal change 502-1.6
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	Seal change 902-3.6
25	
26	Seal change 902-4.8; seal change 902-4.10
27	
28	Seal change 310-3.6; seal change 602-2.8

K-1215 Scale House Sampling. The K-1215 scale house is located outside the fenced security area about 3600 feet northeast of the K-311-1 cascade purge facility as seen in figure 1. The air sampler was located on the southwest corner of the building at a height of six feet. The data obtained on samples from this location are shown in table IV.

TABLE IV

URANIUM CONCENTRATION IN AIR AT K-1215 SCALE HOUSE

Date of Sample	Soluble Uranium Content, (U^{+6}), µg/cu ft	Total Uranium Content, ($U^{+6}+U^{+4}$), µg/cu ft
February 9, 1970	0.002×10^{-2}	0.006×10^{-2}
February 10, 1970	0.002×10^{-2}	0.004×10^{-2}
February 11, 1970	0	0.001×10^{-2}
February 12, 1970	0	0.001×10^{-2}
February 13, 1970	0.008×10^{-2}	0.020×10^{-2}
February 16, 1970	0.001×10^{-2}	0.011×10^{-2}
February 17, 1970	0.002×10^{-2}	0.011×10^{-2}
February 18, 1970	0.001×10^{-2}	0.001×10^{-2}

A portion of the samples obtained on February 10, 1970 and February 13, 1970 has been submitted to Dr. A. E. Cameron of ORNL for gross isotopic analysis to try to identify the source of the uranium-bearing effluent.

Safety Sign (East) Sampling. The safety sign is also located outside the fenced security area on the Oak Ridge Turnpike about 7200 feet east of the K-311-1 cascade purge facility as shown in figure 1. The air sampler was located on the northwest corner of the sign at a height of six feet. The data for samples from this location are shown in table V.

A portion of the samples obtained on February 10, 1970 and February 13, 1970 has been submitted to Dr. A. E. Cameron for gross isotopic analysis to try to identify the source of the uranium-bearing effluent.

TABLE V

URANIUM CONCENTRATION IN AIR AT SAFETY SIGN (EAST)

Date of Sample	Soluble Uranium Content, (U^{+6}), µg/cu ft	Total Uranium Content, ($U^{+6}+U^{+4}$), µg/cu ft
February 9, 1970	0.001×10^{-2}	0.001×10^{-2}
February 10, 1970	0.005×10^{-2}	0.012×10^{-2}
February 11, 1970	0	0.001×10^{-2}
February 12, 1970	0.001×10^{-2}	0.001×10^{-2}
February 13, 1970	0.004×10^{-2}	0.004×10^{-2}
February 16, 1970	0.001×10^{-2}	0.001×10^{-2}
February 17, 1970	0.001×10^{-2}	0.002×10^{-2}
February 18, 1970	0.001×10^{-2}	0.001×10^{-2}

Isotopic Analyses of Oxide Transfer Facility. Selected air samples that were obtained in October, 1969, at the K-1420 oxide transfer facility were submitted to Dr. A. E. Cameron for gross isotopic analyses of the uranium isotopic composition. The samples obtained in the operating area were taken at a point six feet above the floor just outside the containment area (which is similar to an exhaust hood). Other samples were obtained at the roof exhaust vent. The exhaust from the containment area is passed through absolute filters before being discharged through the roof exhaust vent.

The results of the isotopic analyses are presented in table VI of this report. A comparison of the data from the samples obtained on October 3, 1969 shows that the material in the sample obtained in the operating area is not being exhausted through the absolute filters. The sample obtained on the roof had a U^{235} content of 3.377 percent, which was higher than that obtained in the operating area (2.802%). The uranium oxides being processed in this facility on this day had isotopic compositions of less than 3 percent U^{235}. A comparison of the data from the samples obtained on October 13, 1969 shows similar results. The oxide transfer facility was not operating this day, but the facility was being cleaned after handling uranium oxides of the same U^{235} content as on October 3, 1969. These data indicate that the material from the operating area of the oxide transfer facility apparently was being trapped in the absolute filter in the roof exhaust vent. The higher assay of the material found in the analyses of the samples obtained near the roof exhaust vent of

TABLE VI

GROSS ISOTOPIC ANALYSES OF ORGDP AIR SAMPLES*

Sampling Location	Percent U^{234}	Percent U^{235}	Percent U^{236}	Percent U^{238}	U^{235}/U^{234}	U^{238}/U^{234}	U^{235}/U^{236}	U^{238}/U^{236}	U^{235}/U^{238}
Samples Obtained Friday, October 3, 1969									
K-1420, Oxide Transfer Facility									
Operating Area	0.0188	2.803	0.02068	97.157	149.3	5163.2	135	4690	0.0288
Oxide Facility Roof Exhaust Vent	0.0264	3.377	0.02410	96.558	127.8	3656.3	138	3990	0.0349
K-1420, Calciner Facility									
Operating Area	0.0515	6.024	0.04211	93.882	116.9	1820.8	143	2220	0.0641
Calciner Roof Exhaust Stack	0.1474	18.754	0.15891	80.940	127.1	548.9	118	509	0.2310
Samples Obtained Monday, October 13, 1969									
K-1420, Oxide Transfer Facility									
Operating Area	0.0211	2.824	0.01712	97.137	134.0	4602.3	165	5670	0.0290
Oxide Facility Roof Exhaust Vent	0.0316	3.689	0.02553	96.254	116.7	3047.2	144	3760	0.0383
K-1420, Calciner Facility									
Operating Area	0.1777	23.056	0.22198	76.536	129.7	430.5	103	344	0.3010
Calciner Roof Exhaust Stack	0.0279	3.683	0.02418	96.265	132.5	3454.5	151	3970	0.0382

*Analyses performed by Dr. A. E. Cameron, ORNL.

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the building could be influenced by effluent from the exhaust stack of the calcining facility. A check on this facility showed that on October 3, 1969, two different uranyl nitrate solutions were calcined, one containing 1.86 percent U^{235} and one containing 29.7 percent U^{235}. On October 13, 1969, the calcining facility was processing solutions containing 29.6 percent U^{235}.

The results of these analyses indicate that this facility is difficult to identify by gross isotopic analyses, since samples taken outside the building appear to be influenced by the effluent from the calcining facility which is located in the same building.

Isotopic Analyses of Calcining Facility. Air samples obtained during October, 1969, at the K-1420 uranium calcining facility were submitted to Dr. A. E. Cameron for gross isotopic analyses of the uranium isotopic composition. This facility is used to calcine uranyl nitrate solutions into uranium oxide. The uranyl nitrate solutions are composed of dissolved uranium compounds of varying degrees of enrichment. The exhaust stack from the calciner is vented directly to the atmosphere.

The results of the isotopic analyses for the samples are presented in table VI of this report. The results of the analyses of the samples obtained on October 3, 1969 show that the assay of the material from the roof exhaust stack and the material from the operating area are quite different. However, when these samples are compared with known gradients plotted as U^{235}/U^{234} ratios as a function of U^{238}/U^{234} ratios and U^{235}/U^{236} ratios as a function of U^{238}/U^{236} they appear to be Portsmouth cascade material diluted with natural uranium. This is a reasonable interpretation, since the records of the calciner facility show that material recovered at the Y-12 Plant (which handles Portsmouth material) was being processed on the day the samples were obtained. The assay of the Y-12 material being processed on this day was 29.7 percent U^{235}. In addition, uranyl nitrate solutions with an assay of 1.86 percent U^{235} were also processed in the calciner on this day. Similar results were obtained for the samples taken on October 13, 1969.

The information obtained from these samples shows the calciner to be a source of uranium-bearing effluent, but because of the wide range of U^{235} compositions in the materials being processed, this source is difficult to identify by gross isotopic analyses.

Isotopic Analyses of Water Tank and Switch House Samples. Selected air samples that were obtained during the month of November, 1969 at the K-704 switch house (a distance of 7600 feet southwest of the cascade purge facility) and the K-1528 water tank (a distance of 5400 feet south-southeast of the cascade purge facility) were submitted to Dr. A. E. Cameron for gross analyses of the uranium isotopic composition. These samples were taken to determine if the cascade top purge could be detected at these locations.

The results of the isotopic analyses are shown in table VII of this report. All four of these samples appear to be present day ORGDP effluent mixed with tails and natural uranium. None of these samples appear to contain material from the cascade purge facility.

Basic Studies

Effect of Local Weather Conditions on UO_2F_2 in the Presence and Absence of Sunlight. A series of samples of UO_2F_2 and mixtures of UO_2F_2 with powdered aluminum, chromium, and tungsten were exposed to local weather conditions. Some of the samples were exposed to sunlight while others were masked from the sunlight. The samples were chemically analyzed for soluble uranium (U^{+6}) and total uranium ($U^{+6}+U^{+4}$) content.

The results of the chemical analysis of these samples are shown in table VIII. Results of an X-ray diffraction analysis of each set of samples are also included in the table. The difference in the results could be due to the effect of the presence of sunlight or it could be due to the fact that, in the experiment in which the mixtures were masked from the sunlight, there was much less moisture condensed out of the air in the sample container.

TABLE VII

GROSS ISOTOPIC ANALYSES OF ORGDP AIR SAMPLES*

Sampling Location	Percent U^{234}	Percent U^{235}	Percent U^{236}	Percent U^{238}	U^{235}/U^{234}	U^{238}/U^{234}	U^{235}/U^{236}	U^{238}/U^{236}	U^{235}/U^{238}
Samples Obtained Thursday, November 6, 1969									
K-1528 Water Tank	0.0051	0.729	0.00304	99.263	141.5	19343.6	237	32300	0.00734
K-704 Switch House	0.0064	0.711	0.00472	99.277	104.5	14596.6	145	20200	0.00716
Samples Obtained Thursday, November 13, 1969									
K-1528 Water Tank	0.0051	0.637	0.00628	99.351	129.8	19920.3	109	16600	0.00641
K-704 Switch House	0.0035	0.509	0.00437	99.482	146.3	27963.1	113	22100	0.00511

*Analyses performed by Dr. A. E. Cameron, ORNL.

TABLE VIII

ANALYSES OF UO_2F_2-METAL MIXTURES AFTER 60-DAY EXPOSURE TO LOCAL WEATHER WITH AND WITHOUT SUNLIGHT

Material	Soluble Uranium, (U^{+6}), %	Insoluble Uranium, (U^{+4}), %	X-Ray Diffraction Analysis
With Sunlight			
UO_2F_2	98.43	1.57	$UO_2F_2.2H_2O$
UO_2F_2 + Aluminum Powder	11.18	88.82	Aluminum + unidentified material
UO_2F_2 + Chromium Powder	95.43	4.57	Chromium + $UO_2F_2.2H_2O$ + unidentified material
UO_2F_2 + Tungsten Powder	73.82	26.18	Tungsten + unidentified material
Without Sunlight			
UO_2F_2	98.61	1.39	$UO_2F_2.2H_2O$
UO_2F_2 + Aluminum Powder	83.88	16.12	Aluminum + $UO_2F_2.2H_2O$
UO_2F_2 + Chromium Powder	96.51	3.49	Chromium + $UO_2F_2.2H_2O$
UO_2F_2 + Tungsten Powder	96.28	3.72	Tungsten + $UO_2F_2.2H_2O$

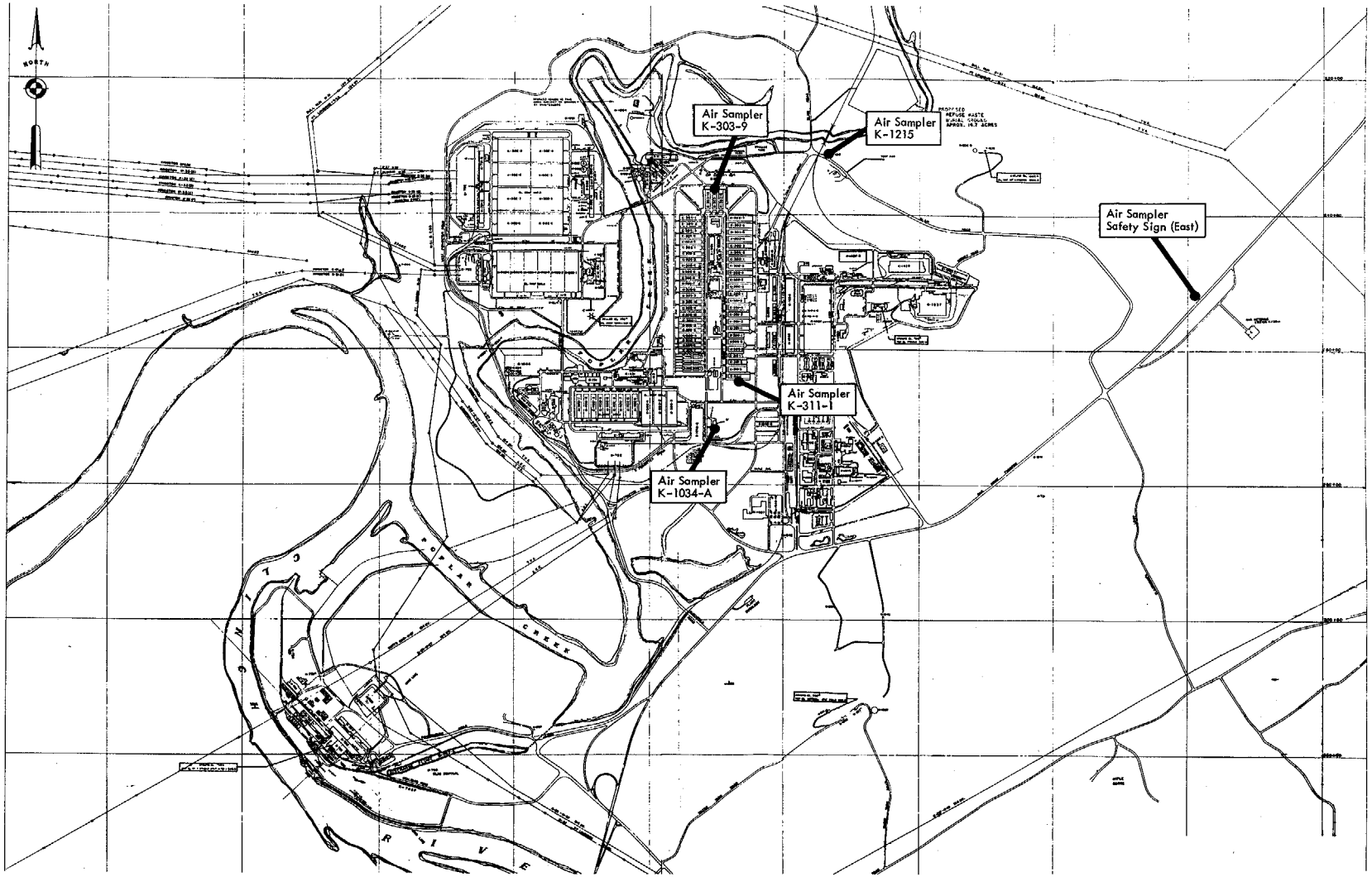

Figure 1
AIR SAMPLING LOCATIONS

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DWG. NO. G-70-139

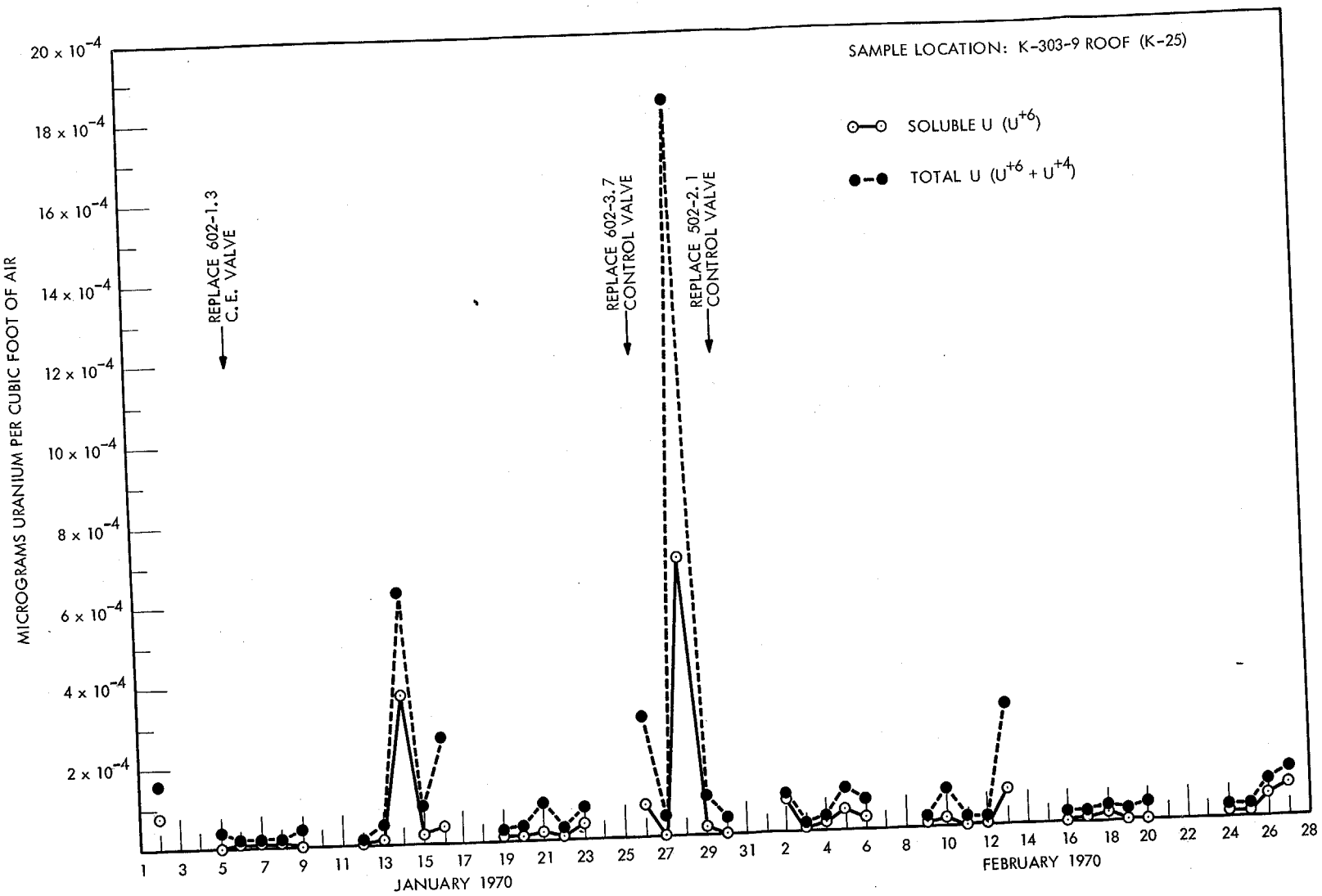

Figure 2
DAILY CONCENTRATION OF URANIUM IN AIR

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DWG. NO. G-70-140

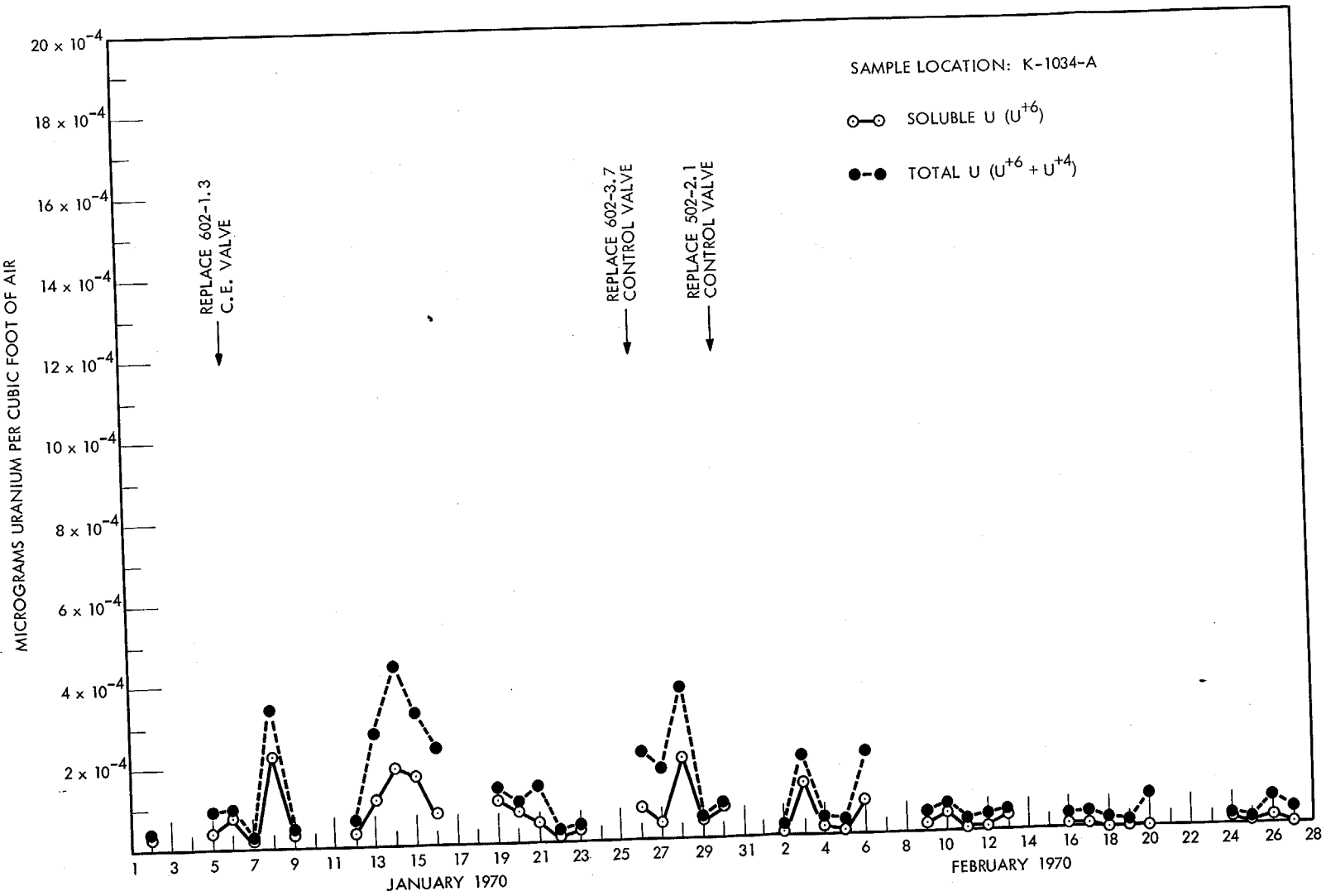

Figure 3
DAILY CONCENTRATION OF URANIUM IN AIR